CONSTRUCTION SPECIFICATION

NV-62. GROUTED ROCK RIPRAP

1. SCOPE

The work shall consist of furnishing, transporting, and placing rock and concrete grout, including filter, bedding or geotextile materials where specified, in the construction of grouted rock riprap sections as shown on the construction drawings.

2. MATERIALS

Rock fragments shall be dense, sound and free from cracks, seams and other defects conducive to accelerated weathering. The rock fragments shall be angular to subrounded in shape. The least dimension of each individual rock fragment shall be not less than one-third the greatest dimension of the fragment. It should also be free from dirt, clay, sand, rock fines and other materials not meeting the gradation limits. Rock shall be excavated, selected and handled as necessary to meet the grading requirements on the drawings. The rock shall be obtained from specified sources or sources as approved by the Technician.

Filter or bedding materials, if specified, shall be selected to meet the grading requirements as shown on the drawings.

Portland cement shall conform to ASTM Specification C 150 and shall be Type 1P(MS), II, IIA, or V.

Fine aggregate shall conform to ASTM Specification C 33 and be composed of clean, uncoated grains of material.

Coarse aggregates shall be gravel or crushed stone conforming to ASTM Specification C 33 and be clean, hard, durable and free from clay or coating of any character.

Water used in mixing or curing concrete shall be clean and free from injurious amounts of oil, salt, acid, alkali, organic matter, or other deleterious substances.

Air entraining agent shall conform to ASTM Specification C 260.

Pozzolan (fly ash) shall conform with ASTM Specification C 618, Class F or C. The loss of ignition shall not exceed 6.0 percent.

Water-reducing admixtures shall conform to ASTM Specification C 494 and may be the following types:

1. Type A - Water-reducing admixture.
2. Type D - Water-reducing and retarding mixture.
3. Type F - Water-reducing, high range admixture (superplasticizer).
4. Type G - Water-reducing, high range, and retarding admixture (superplasticizer).

Type D or G admixture may be used at the option of the Contractor/Supplier when the air temperature is over 80^0F at the time of mixing and/or placement.

Calcium chloride or other antifreeze compounds or accelerators will not be allowed.

Curing compound shall conform to ASTM Specification C 309 and unless otherwise specified the compound shall be Type 2.

3. SUBGRADE PREPARATION

The subgrade surfaces on which the riprap, filter or bedding material is to be placed shall be cut or filled and graded to the lines and grades as shown on the drawings or as directed by the Technician. When fill to subgrade lines is required, it shall consist of approved materials and shall be compacted as specified in Construction Specification NV-23, Earthfill.

Riprap, filter or bedding shall not be placed until the foundation preparation is completed, and approved by the Technician.

4. FILTER AND BEDDING MATERIALS

Filter or bedding material, when required, shall be spread uniformly on the prepared subgrade surfaces to the depth shown on the drawings. The surfaces of the layers shall be finished reasonably free of mounds, dips or windrows.

Geotextile, when required, shall meet the requirements shown on the drawings and as specified in Construction Specification NV-95, Geotextile.

5. ROCK GRADATION AND MINIMUM GROUT PENETRATION

The rock gradation and the minimum grout depth shall be as selected from the following table or as otherwise specified on the drawings.

Rock Diameter	**Maximum Rock Size (D_{100})**					
	38 Inch	**30 inch**	**24 inch**	**19 inch**	**14 inch**	**10 inch**
	Rock Gradation (Percentage Passing)					
38 inch	95-100					
30 inch	0-50	95-100				
24 inch	---------	0-50	95-100			
19 inch	0-5	---------	0-50	95-100		
14 inch		0-5	---------	0-50	95-100	
10 inch			0-5	---------	0-50	95-100
8 inch				0-5	---------	0-50
7 inch					0-5	0-5
Minimum Grout Depth (inches)	24	18	14	9	7	5

6. PLACING ROCK RIPRAP

The rock shall be placed on the surfaces and to the depths specified in such a manner as to avoid displacement of underlying materials. The rock may be equipment or hand placed as necessary to produce a surface in which the tops of the individual rocks do not vary more than one quarter of the D_{50} (1/4 * D_{50}) or specified deviation from the neat lines shown on the drawings. Rock shall also be placed in a manner to prevent damage to structures. Hand placing may be required to prevent damage to the permanent works. Double decking of thin, flat rocks to bring the surface up to the required grade will not be permitted.

7. DESIGN OF THE GROUT MIX

The Contractor shall be responsible for proportioning the mix.

The grout shall consist of portland cement, fine and coarse aggregate, and water, unless otherwise specified. The cement content shall be 6 bags per cubic yard (564 lb.), fine to coarse aggregate ratio shall be greater than 0.35 but less than 0.45, maximum nominal size of coarse aggregate shall be 3/4 inch, and water-cement ratio shall be greater than 0.45 but less than 0.53 (maximum content of six (6) gallons of water per sack of concrete).

Pozzolan (Fly ash) may be used as a partial substitution for portland cement in an amount not greater than twenty (20) percent (based on absolute volume) of cement in the concrete mix, unless otherwise specified.

Prior to placement of grout, the Contractor shall furnish the Technician a certification of the mix proportions for approval. After the mix has been approved, neither the source nor character of the aggregates nor the type or brand of cement nor the mix proportions will be changed without prior approval of the Technician.

8. AIR CONTENT AND CONSISTENCY

Air entrainment may be used and shall not exceed seven (7) percent at time of placement.

The consistency of the grout mixture shall be such that it will penetrate the rock to the minimum depth specified in Section 5. Unless otherwise specified, the maximum slump shall be eight (8) inches.

9. MIXERS AND MIXING

The mixer, when loaded to capacity, shall be capable of combining the ingredients of the grout mix into a thoroughly mixed and uniform mass and of discharging it with a satisfactory degree of uniformity.

The mixer shall be operated within the limits of the manufacturer's guaranteed capacity and speed of rotation.

The time of mixing after all cement and aggregates are in the mixer drum shall be not less than one minute for mixers having a capacity of one cubic yard or less. For mixers of larger capacities, the minimum time shall be increased fifteen seconds for each cubic yard or

fraction thereof of additional capacity. The batch shall be charged into the mixer so that some water will enter in advanced of the cement and aggregate, and all mixing water shall be introduced into the drum before one-fourth of the mixing time has elapsed.

When ready-mixed grout mix is furnished, the Contractor shall furnish to the Technician a delivery ticket showing the time of loading and the quantities of materials used for each load of grout mix. The ticket shall show the total weights in pounds of cement, water, fine and coarse aggregates, amount of air-entraining agents, other admixtures, time of loading and the revolution counter reading at the time of batching.

No mixing water in excess of the amount called for by the job mix shall be added to the grout mix during mixing or hauling or after arrival at the delivery point.

10. CONVEYING AND PLACING GROUT

The grout mix shall be delivered to the site and placed within 1-1/2 hours after the introduction of the cement to the aggregates. In hot weather or under conditions contributing to quick stiffening of the concrete, the time between the introduction of the cement to the aggregates and discharge shall not exceed 45 minutes. The Technician may allow a longer time, provided the setting time of the concrete is increased a corresponding amount by the addition of an approved set-retarding mixture. In any case, concrete shall be conveyed from the mixer to the final placement as rapidly as practicable by methods that will prevent segregation of the aggregates or loss of mortar.

Grout mix shall not be dropped more than five (5) feet vertically unless suitable equipment is used to prevent segregation.

The grout mix shall not be placed until the rock riprap has been inspected and approved by the Technician.

The rock riprap shall be flushed with water to remove the fines from the rock prior to placing the grout. The rock shall be kept moist for at least two (2) hours immediately prior to the actual placement of grout, but the grout shall not be placed in standing or flowing water. Grout placed on inverts or other nearly level areas may be placed in one course. On slopes, the grout shall be placed in two (2) courses in successive lateral strips approximately ten (10) feet in width starting at the toe of the slope and progressing to the top. The grout shall be delivered to the place of final deposit by any means that does not result in segregation by gravity. The flow of grout shall be directed with brooms, spades or baffles to prevent it from flowing excessively along the same path and to assure that all intermittent spaces are filled. Sufficient rodding shall be done to loosen tight pockets of rock and otherwise aid the penetration of grout so that all voids shall be filled and the grout fully penetrates the rock blanket to the minimum depth specified. The entire surface shall be broomed to eliminate runs and to fill voids caused by sloughing. A surface finish, following the completion of grout installation, shall consist of one-third of the rock extending above the level of the grout or to the minimum depth specified on the drawings. The exposed rock will not have a plastered appearance.

11. CURING AND PROTECTION

After completion of any strip or panel, no construction personnel or other load shall be permitted on the grouted surface for a period of twenty-four (24) hours. The grout shall be prevented from drying for a curing period of at least seven (7) days after it is placed. Exposed surfaces shall be kept continuously moist for the entire period. Moisture shall be maintained by sprinkling, flooding or fog spraying or by covering with continuously moistened canvas, cloth mats, straw, earth, or moistening and covering with plastic sheeting, or other approved material.

In lieu of water curing, the grout may be cured by spraying with an approved curing compound. The curing compounds shall be applied an approved manner as soon as practicable after the concrete is placed. All surfaces shall be kept moist until the compound is applied.

Grout mix shall not be placed when the daily temperature is less than 40^0F unless facilities are provided to insure that the temperature of the materials is maintained at not less than 50^0F nor more than 90^0F during placement and the curing period. Grout mix shall not be placed on frozen surfaces. When freezing conditions prevail, rock to be grouted must be covered and heated to a range of 50^0F to 90^0F for at least 24 hours prior to placing treatment materials.